

# **A SHORT-TERM FORECASTING MODEL FOR THE SPANISH ECONOMY: GDP AND ITS DEMAND COMPONENTS**

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## **Abstract**

This document describes the key aspects of the extended and revised version of Spain-STING (Spain, Short-Term INDicator of Growth), which is a tool used by the Banco de España for the short-term forecasting of the Spanish economy's GDP and its demand components. Drawing on a broad set of indicators, several dynamic factor models are estimated. These models allow the forecasting of GDP, private consumption, public expenditure, investment in capital goods, construction investment, exports and imports in a consistent way. We assess the predictive power of the GDP and its demand components for the period 2005-2017. With regard to the GDP forecast, we find a slight improvement on the previous version of Spain-STING. As for the demand components, we show that our proposal is better than other possible time series models.

**Keywords:** business cycles, spanish economy, dynamic factor models.

**JEL classification:** E32, C22, E27.

## Resumen

En este trabajo se propone una nueva versión ampliada y revisada del modelo Spain-STING (*Spain, Short-Term Indicator of Growth*), que es una herramienta utilizada por el Banco de España para la previsión a corto plazo del PIB de la economía española. Asimismo, se desarrollan modelos de predicción para cada uno de los componentes de la demanda: el consumo privado, el gasto público, la inversión en bienes de equipo, la inversión en la construcción, las exportaciones y las importaciones de bienes y servicios. A partir de un amplio conjunto de indicadores, se estiman varios modelos factoriales dinámicos. Esta metodología permite realizar predicciones, de forma consistente, del PIB y de sus seis componentes de demanda. Se realiza una evaluación del poder predictivo del PIB y de sus componentes de demanda para el período 2005-2017. Con respecto a la predicción del PIB, se observa una ligera mejoría con respecto a la versión anterior del Spain-STING. En lo que respecta a los componentes de demanda, se observa que el modelo propuesto en este trabajo tiene mayor capacidad predictiva que otras posibles herramientas de series temporales.

**Palabras clave:** ciclos económicos, economía española, modelo factorial dinámico.

**Códigos JEL:** E32, C22, E27.

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## 1 Introduction

The analysis of the economy's short-term situation, and the projection of its future course, are fundamental tasks of central banks and national and international institutions. The monitoring of the economic cycle and the conducting of short and medium-term macroeconomic projection exercises require work that involves drawing together the latest economic indicators within the framework of the national accounts.

The Spain-STING (Spain, Short-Term INDicator of Growth) model is a short-term forecasting tool (e.g. one or two quarters ahead) for the quarterly growth rate of the Spanish economy's GDP [see Camacho and Pérez Quirós (2009 and 2011)] in real time, i.e., as new data on the explanatory variables are published. This model is made up of GDP, in a quarterly frequency, and ten monthly economic indicators that offer information on recent economic developments.

Spain-STING jointly models the dynamics of each of its eleven variables (GDP + ten indicators) and distinguishes between a common part (that is captured by the common factor) and an idiosyncratic part associated with each of these variables. This tool enables forecasts to be made on the variables included in the model, taking into consideration both the predictive power of each variable and the availability of information. The model has been used as an internal short-term forecasting tool at the Banco de España since late 2009.<sup>1</sup>

This document presents an extended and revised version of the Spain-STING model, designed expressly to incorporate forecasts of all the demand components of the Spanish economy's macroeconomic aggregates: private consumption, public expenditure, investment in capital goods, construction investment, exports and imports.<sup>2</sup> The estimation is carried out by means of individual dynamic factor models. The estimation of all the macroeconomic aggregates allows us not only to forecast real-time GDP but also to incorporate information on the components that explain the forecast, making it possible to deepen the analysis of the causes behind changes in GDP forecasts.<sup>3</sup> Furthermore, this short-term forecasting model for the GDP and its demand components is estimated in a consistent way, using a balancing procedure. This means that all the individual predictions are globally consistent when they are aggregated. Finally, the predictive power of the new version of the Spain-STING and the six demand components is assessed for the period 2005-2017. With regard to the GDP forecast, we find a slight improvement on the previous version of Spain-STING. As for the demand components, we show that our proposal is better than other possible alternatives.

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<sup>1</sup> There is also a similar model for economic forecasting in the euro area. See Camacho and Pérez-Quirós (2010) and Burriel and García-Belmonte (2013).

<sup>2</sup> Arencibia et al. (2017) present a brief summary of this model.

<sup>3</sup> Very few central banks have tools of this type. The recent advances made by the Federal Reserve Bank of Atlanta with its GDPNow project and the Federal Reserve Bank of New York's Nowcast project merit a mention. In the case of the Spanish economy, solely AIReF with its MIPRED model has a similar model [see Cuevas et al. (2017)]. Nevertheless, Banco de España uses different additional methodologies to carry out forecasting exercises. See, for instance, Álvarez et al. (2014).



The rest of the paper is structured as follows. Section 2 describes the econometric methodology and the characteristics of the set of indicators that are part of the database used to forecast GDP. In Section 3, the models for the different demand components and the aggregation method used so as to have a consistent overall forecast are presented. Section 4 analyses, firstly, the new model's predictive power for GDP which is compared with that of the previous model and, secondly, the forecasting performance of the different demand components models relative to alternative time series models. Finally, Section 5 concludes.

## 2 Description of the GDP model

In this section, we explain in detail the model to compute short term forecasts of the Spanish GDP growth in real time from a wide set of indicators that may include mixed frequencies and missing observations.

The characteristics of this model enable a response to be given to various problems of forecasting GDP in real time. Specifically, the Spain-STING model is constructed with: (i) information that is not balanced out at the end of the sample (i.e. combining indicators released with a lag with others which, by their nature, are available sooner); (ii) a mix of frequencies (i.e. with monthly indicators to bring forward the quarterly GDP growth rate); (iii) different types of data (survey-based and real activity indicators); (iv) information relating to different periods of activity (annual, quarterly and monthly); and (v) data that are not always available for the whole sample analysed.

Spain-STING captures the dynamics of each indicator (including those of GDP) and distinguishes between a common part, captured in the factor, and an idiosyncratic part, which determines the movements of each of the indicators not explained by the dynamics of that common factor. Under this system, the developments in each indicator help anticipate the trend of the common component and, therefore, that of GDP. As a result, the forecast is made taking into account the predictive power of each variable and the availability of information, which enables the relative significance of each indicator for the forecasting of GDP to be adjusted.

### 2.1 Methodology

Spain-STING, based on Camacho and Pérez-Quirós (2009 and 2011), is a small-scale dynamic factor model made up of GDP, whose publication is quarterly and several monthly indicators. In its current specification, there are ten monthly indicators, eight of which relate to real activity (the non-energy industrial production index, General Social Security Regime registrations, real sales by large non-financial corporations, electricity consumption in industry, apparent consumption of cement and real goods exports and imports), and two to survey-based data [PMI and ESI (Economic Sentiment Indicator)].<sup>4</sup> However, these indicators are not the same than those included in the original version of the model, as explained below.

This type of model obtains early estimates of quarterly GDP growth through monthly indicators whose information is posthaste available. In order to link monthly data with quarterly observations, it is required to express quarterly growth rates observations as the evolution of monthly figures. To accomplish this, let us assume that the levels of the quarterly GDP can be decomposed as the sum of three unobservable monthly values of GDP. If the sample mean of these three data can be adequately approximated by the geometric mean, the quarterly growth rate of GDP can be expressed as the average of monthly growth rates of latent observations, as it is shown by Mariano and Murasawa (2003):

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<sup>4</sup> Specifically, the composite PMI and the ESI without the consumer component are used.

$$y_t = \frac{2}{3} x_t + \frac{1}{3} x_{t-1} + x_{t-2} + \frac{1}{3} x_{t-3} + \frac{2}{3} x_{t-4}$$

One must note that approximating sample means with geometric means is appropriate due to the fact that the evolution of macroeconomic series is smooth enough to allow for this approximation.

The mechanism described above display two econometric problems. The first one is that the procedure is specified in monthly frequencies. Thus it requires to estimate unobserved components such as monthly growth rates and quarterly growth rates for the first two months of each quarter. The other difficulty is given by the use of some series that start too late and some (those with longer publication delays) that end too soon, which causes many missing observations.

The appropriate tool to deal with these disadvantages are dynamic factor models. These models are also suitable to characterize comovements in macroeconomic variables that admit factor decompositions. The premise of a dynamic factor model is that the dynamic of each series can be decomposed into two orthogonal components. The first component, named common component and denoted by  $f_t$ , captures the collinear dynamics affecting all variables. It can be interpreted as a coincident indicator of the GDP growth rate. The second component, named idiosyncratic component and denoted for each indicator  $j$  by  $u_{jt}$ , captures the effect of those dynamics which only affect that specific indicator.

Let  $x_t$  be the monthly GDP growth rate and let  $z_t$  be the  $k$ -dimensional vector of economic indicators in monthly growth rates (hard indicators) or levels (soft indicators).<sup>5</sup>

The model can then be stated as

$$\begin{pmatrix} x_t \\ z_t \end{pmatrix} = \beta f_t + \begin{pmatrix} u_{yt} \\ u_{zt} \end{pmatrix}$$

where  $u_{zt} = (u_{1t}, u_{2t}, \dots, u_{kt})$ . The  $(k+1)$  parameters in  $\beta$  capture the correlation between the unobserved common factor and the variables and are known as the factor loadings. Furthermore, we assume the following dynamic specification for the variables

$$\begin{aligned} \phi_y(L)u_{yt} &= \varepsilon_{yt}, \\ \phi_f(L)u_{ft} &= \varepsilon_{ft}, \\ \phi_i(L)u_{it} &= \varepsilon_{it}, i = 1, \dots, k, \end{aligned}$$

where  $\phi_y(L)$ ,  $\phi_f(L)$  and  $\phi_i(L)$  are lag polynomials of order  $p$ ,  $q$  and  $r$ , respectively.

<sup>5</sup> Introducing indicators in levels creates the problem of mixing integrated and stationary variables in the same specification. We solve this issue by considering, as pointed out by the European Commission (2006), that soft indicators are related to the annual growth rates of the variable of interest. Therefore, the level of the soft indicators depends on a 12 month moving average of the common factor, and this is the source of its unit root.

Additionally, we consider that all the errors in these equations are independent and identically normal distributed with zero mean and diagonal covariance matrix.

When all the variables are observed in each period, the model can be easily stated in state space representation which can be estimated by maximum likelihood procedures [see Hamilton (1994)]. Furthermore, the Kalman filter is the usual statistical method to deal with missing observations. As in Mariano and Murasawa (2003), we substitute the missing observations with random draws (means, medians or zeroes are also valid alternatives). The substitutions allow the matrices in the state-space representation to be similar. However, they do not impact on the model estimation due to the missing observations add just a constant in the likelihood function to be estimated by the process.

The model can be written in state space form. Let us collect the quarterly growth rates of GDP and the monthly growth rates of the ten indicators in the vector  $Y_t = (y_t, z'_t)'$  and their idiosyncratic components in the vector  $u_t = (u_{y,t}, u'_{z,t})'$ . The observation equation is

$$Y_t = Hs_t + w_t,$$

where  $w_t \sim iN(0, R)$ . The transition equation is

$$s_t = Fs_{t-1} + v_t,$$

where  $v_t \sim iN(0, Q)$ .

The details about the specific form of the matrix  $H$  when dealing with quarterly growth rates and monthly growth rates of monthly indicators and indicators in levels are described in Appendix 1.

Weights or cumulative impact of each indicator to the forecast GDP growth are another interesting outcome from dynamic factor models. This result can be obtained from the Kalman filter. Moving forward, the state vector  $s_t$  can be expressed as the weighted sum of observations available in the past.<sup>6</sup> Assuming a large enough  $t$ , such that the Kalman filter has approached its steady state, it holds that  $h$ -period ahead forecasts of GDP growth are approximately

$$y_{t+h} = \sum_{j=0}^{\infty} W'_j Y_{t-j}$$

In this expression,  $W_j$  is the vector of weights and leads the forecaster to compute the cumulative weight of series  $i$  in forecasting GDP growth as  $\sum_{j=0}^{\infty} W_j(i)$ , where  $W_j(i)$  is the  $i$ -th element of  $W_j$ .

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<sup>6</sup> See Stock and Watson (1991) for further details.

## 2.2. Selection of variables

This section explains the process to select the series included in the estimation. The model uses ten monthly indicators, eight of which relate to real activity and two to survey-based data. All these variables are listed in Table 1.

The selection of the variables aforementioned is based on Camacho and Pérez-Quirós (2009 and 2011). The idea is to begin with a very parsimonious specification, with a small set of indicators, in line with Stock and Watson (1991), and only extend the model to include new indicators when they make the variance of GDP explained by the common factor to increase. The variables that most contribute to increase the variance explained by the model are those included first. No further variables are included in the model when they are correlated among themselves and thus, including them biases the factor. For example, if the additional variables are correlated with the idiosyncratic part of any of the other variables, the estimation of the common factor will be biased towards this sub-group, impairing the relationship between GDP and the factor. If this happens, including additional variables would not increase the explanatory power over GDP dynamics.

The main differences of the current model with respect to Camacho and Pérez-Quirós (2009 and 2011) are the following. First, the possibility of all indicators not being coincident (i.e. that despite being dated in a specific period “t” they refer to activity in a subsequent period) was introduced, meaning that leads on certain series were included, such as consumption of cement and the survey-based indicators, which in their original version were specified contemporaneously.<sup>7</sup> Second, practical experience showed that some of the indicators originally introduced into the model had no explanatory power,<sup>8</sup> whereas others that were not initially included might marginally improve the performance of the model. Accordingly, credit to non-financial corporations was introduced, which enhanced the explanation of the last recessionary period. These two changes were made in 2013. Finally, in the latest extension of the model, which is carried out in this paper,<sup>9</sup> the indicators are included as monthly rather than annual growth rates. This entails a technical improvement: given that GDP is measured in quarterly terms, by considering the indicators as annual rates a structure of lags between the GDP ratio and each indicator was assumed.

After estimating this revised version of the model, which includes the three detailed improvements, we can observe that it fits the GDP data precisely. In particular, we evaluate the fit of the model by computing the proportion of variance of the GDP explained by the common factor. In the version proposed here, this proportion reaches 92% of the variance of GDP. When compared to the GDP flash estimate,<sup>10</sup> the proportion increases to over 93% which stems from

<sup>7</sup> They were introduced with a lead of three months. In the case of consumption of cement, by its own idiosyncrasy, leads GDP. Three months is the preferred lead time, as it is when the correlation between the indicator and activity is higher. In the case of survey-based indicators, it is because of their design, as their questionnaires refer to the evolution that agents expect to have in a three month time horizon, i.e., they reflect expectations and, therefore, are introduced with leads.

<sup>8</sup> Specifically, the original version of the model included some indicators that have been removed in the current version. Those are retail sales confidence indicator (RS), industrial confidence indicator (ICI) and overnight stays (nights spent by foreigners in hotels). Also, the original version included services purchasing managers index (PMI) and it has been changed by composite purchasing managers index (PMI).

<sup>9</sup> The results are summarised in Arencibia et al. (2017).

<sup>10</sup> The flash is an estimated growth rate of the GDP with just one decimal. When flash estimates are released, there are no revisions of previous estimates of the GDP growth rates. However, the GDP flash estimate is slightly revised when its full breakdown, i.e., that which includes all macroeconomic aggregates, is published around one month later.

the fact that the latter is based on indicators, whereas subsequent revisions of GDP are related to more structural information on the economy.

Estimating a model such as that proposed has significant advantages. On one hand, a common factor representing the coincident indicator of developments in the Spanish economy, with a monthly frequency, is estimated; and on the other, the model produces forecasts in real time not only for the GDP growth rate but also for all the model variables. This is important for two reasons. First, on publishing any indicator that appears in the model, the information is modified, updating all the forecasts. In that way, each new observation can be broken down into an “expected” part and another part that can be interpreted as a “surprise”. The model thus enables measurement of the contribution of each surprise to the change in expected GDP. Second, the selection of the variables to be included in the estimation is conditioned by the fact that the objective of the model is to forecast GDP.

Contrary to standard techniques, where the explanatory variables always increase explanatory power, in these models the incorporation of additional variables does not necessarily ensure enhanced predictive behaviour. As mentioned before, they may entail more idiosyncratic comovements among the variables that are not related to GDP. Having a GDP forecast as an objective allows for the elimination from the specification of those variables that lessen the correlation of the common factor with GDP and for the maintenance of those others that increase the correlation.

In sum, the new model uses ten indicators that are representative of the Spanish economy, two of which are survey-based indicators (ESI and PMI) and are included in levels, and eight of which are activity indicators, introduced in terms of a monthly growth rate. Also, the ESI, the PMI and apparent consumption of cement are incorporated with a lead of three months. The activity indicators have a monthly frequency and are introduced into the model contemporaneously, while the survey-based indicators, since they are correlated with annual economic activity, are introduced with twelve lags (see Table 1).

INDICATORS SELECTED IN THE GDP FORECASTING MODEL

TABLE 1

	Periodicity/type of indicator	Starting date	Lag in publication
GDP growth	Quarterly/Activity	1990.3	+45 days
Economic Sentiment Indicator (ESI)	Monthly/Survey-based	1990.1	0
Composite PMI	Monthly/Survey-based	1999.8	+2 days
Non-energy Industrial Production Index	Monthly/Activity	1993.2	+35 days
Sales of large firms	Monthly/Activity	1996.2	+32 days
Apparent consumption of cement	Monthly/Activity	1990.1	No set date
Social Security registrations	Monthly/Activity	1990.1	0
Electricity consumption in industry	Monthly/Activity	1990.1	+31 days
Credit to non-financial corporations	Monthly/Activity	1995.2	+30 days
Goods exports	Monthly/Activity	1991.2	+50 days
Goods imports	Monthly/Activity	1991.2	+50 days

SOURCE: Banco de España.

### 3 Description of the demand components model

Following the modelling strategy and the way of selecting variables for the short-term forecasting of Spanish GDP, this section presents an individual dynamic factor model for each demand component: final consumption expenditure of households and NPISHs (non-profit institutions serving households); final consumption expenditure of general government; gross fixed capital formation in capital goods; gross fixed capital formation in construction; and exports and imports of goods and services. Each of these models follows the econometric methodology described in section 2 for the revised GDP model.

#### 3.1 Selection of variables

The selection of the variables included in each model was drawn from the main indicators used by the INE in the preparation of the Quarterly National Accounts,<sup>11</sup> under the premise that the variables should be available timely and provide a meaningful economic signal of the demand components of the national economy

Drawing on this broad set of indicators, a three-step procedure was followed, as suggested by Camacho and Pérez Quirós (2010) and Arencibia et al. (2017), similar to that described earlier for aggregate GDP. First, a minimum set of indicators representative of each demand component is selected. Second, the correlation of each of these indicators with the corresponding demand component is calculated and the four indicators with the highest correlation are chosen to create a “base model”, that is, a dynamic factor model made up of the demand component and those four indicators. For instance, for private consumption, the base model comprises the component itself and the following indicators: total Social Security registrations, the services business activity index, the services PMI and the consumer confidence indicator.

Third, to determine the final selection of indicators to be included in the dynamic factor model of each component, the four indicators initially used in the base model were combined with the other indicators selected as being representative of that component. Then, the variance of each component explained by the common factor is calculated. Further variables are therefore incorporated into the base model, provided in all cases that they increase the variance of the component explained by the common factor. Continuing with the private consumption example, the following indicators were finally selected: total Social Security registrations, the services business activity index, the services PMI, the consumer confidence indicator, the retail trade index, sales of large consumer goods firms, the unemployment rate and the number of credit card transactions.

The start date for the period of assessment of the indicators selected for these models is January 1995. Tables 2 to 7 summarise the indicators considered for each demand component model, the correlation between each indicator and the corresponding component (for example,

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<sup>11</sup> See Álvarez (1989) and Álvarez (2005).

between private consumption and Social Security registrations) and the indicators finally chosen for each model.

The proportion of variance of each component of GDP explained by the common factor in each model is as follows: 59% for private consumption; 79% for public expenditure; 79% for investment in capital goods; 53% for construction investment; 67% for exports of goods and services, and 78% for imports of goods and services.

INDICATORS SELECTED IN THE PRIVATE CONSUMPTION MODEL

TABLE 2

Potential indicators (a)	Correlation with the component	Start of series
<b>Total Social Security registrations</b>	<b>0.71</b>	<b>1995.1</b>
<b>Services Sector Activity Indicator (IASS)</b>	<b>0.68</b>	<b>2000.2</b>
<b>Services PMI</b>	<b>0.66</b>	<b>1995.1</b>
<b>Consumer confidence indicator</b>	<b>0.63</b>	<b>1995.1</b>
<b>Retail trade index</b>	<b>0.59</b>	<b>1995.1</b>
Sales of large firms, number of recipients	0.56	
<b>Sales of large firms, consumer goods</b>	<b>0.48</b>	<b>1995.2</b>
<b>Unemployment rate</b>	<b>0.47</b>	<b>1986.4</b>
Industrial Production Index, consumer goods	0.43	
Card transactions - amount	0.33	
Real wage income indicator	0.31	
<b>Card transactions - number of transactions</b>	<b>0.28</b>	<b>1995.2</b>
Imports of consumer goods	0.24	

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.

INDICATORS SELECTED IN THE PUBLIC EXPENDITURE MODEL

TABLE 3

Potential indicators (a)	Correlation with the component	Start of series
<b>Social Security registrations - general government</b>	<b>0.62</b>	<b>1995.2</b>
<b>Employment income - general government</b>	<b>0.41</b>	<b>1996.3</b>
<b>State expenditure</b>	<b>0.22</b>	<b>1995.1</b>

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.



INDICATORS SELECTED IN THE INVESTMENT IN CAPITAL GOODS MODEL

TABLE 4

Potential indicators (a)	Correlation with the component	Start of series
<b>Industrial Production Index - capital goods</b>	<b>0.66</b>	<b>1995.1</b>
<b>New commercial vehicle registrations</b>	<b>0.63</b>	<b>1995.1</b>
<b>Domestic sales of large firms - equipment and software</b>	<b>0.62</b>	<b>1995.2</b>
<b>Economic Sentiment Indicator (ESI)</b>	<b>0.61</b>	<b>1995.1</b>
Business confidence - employment expectations	0.58	
Business climate index - investment goods	0.51	
Imports of capital goods	0.43	
IBEX-35 index	0.38	
Spain's competitiveness <i>vis-à-vis</i> developed countries	0.32	
Capacity utilisation	0.26	
Lending to resident companies	0.12	
Spain's competitiveness <i>vis-à-vis</i> Euro area 19	0.02	

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.

INDICATORS SELECTED IN THE CONSTRUCTION INVESTMENT MODEL

TABLE 5

Potential indicators (a)	Correlation with the component	Start of series
<b>Social Security registrations - workers in active employment - construction sector</b>	<b>0.80</b>	<b>2001.2</b>
<b>Confidence index - construction sector</b>	<b>0.63</b>	<b>1995.1</b>
<b>Financing to households and NPISHs - housing loans</b>	<b>0.60</b>	<b>1995.2</b>
<b>Apparent consumption of cement</b>	<b>0.52</b>	<b>1995.1</b>
<b>Building permits - total floorspace</b>	<b>0.26</b>	<b>1995.1</b>
<b>Domestic sales of large firms - construction sector</b>	<b>0.17</b>	<b>1995.2</b>
Official tenders	0.11	
House purchases - new housing	0.09	

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.

INDICATORS SELECTED IN THE EXPORTS OF GOODS AND SERVICES MODEL

TABLE 6

Potential indicators (a)	Correlation with the component	Start of series
<b>World goods trade</b>	<b>0.67</b>	<b>1995.2</b>
<b>Industrial Production Index, intermediate goods</b>	<b>0.63</b>	<b>1995.1</b>
<b>Total goods exports</b>	<b>0.60</b>	<b>1995.1</b>
<b>Industry PMI</b>	<b>0.59</b>	<b>1998.2</b>
Business climate index	0.40	
<b>Total tourist inflows</b>	<b>0.34</b>	<b>1995.2</b>
<b>Sales of large firms - exports, deflated</b>	<b>0.22</b>	<b>1995.2</b>
<b>CPI hotels, cafés and restaurants</b>	<b>0.14</b>	<b>2002.2</b>
Travel, credits	0.11	
Export order books - total industry	0.09	

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.

Potential indicators (a)	Correlation with the component	Start of series
<b>Industrial Production Index, intermediate goods</b>	<b>0.74</b>	<b>1995.1</b>
<b>World goods trade</b>	<b>0.71</b>	<b>1995.2</b>
<b>Domestic sales of large firms</b>	<b>0.71</b>	<b>1995.2</b>
<b>Industry PMI</b>	<b>0.70</b>	<b>1998.2</b>
Sales of large firms - imports, deflated	0.64	
Retail trade index	0.60	
Total goods imports	0.53	
Balance of payments - tourism debits	0.09	

SOURCE: Banco de España.

a The indicators finally included in the model are in bold.

### 3.2. Balancing procedure

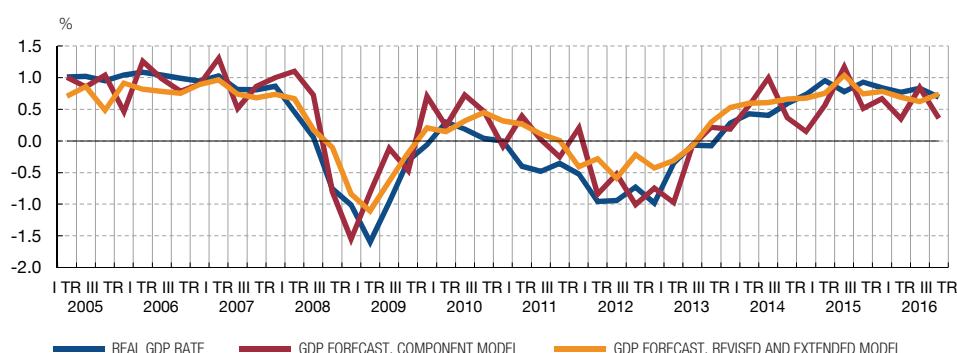
The dynamic factor models for each demand component specified allow a separate forecast to be obtained for each macroeconomic aggregate. In order to obtain a consistent forecast for the entire system, including GDP, each separate forecast must be weighted by the weight of each component in GDP at each point in time, thus obtaining a weighted GDP forecast.

We have compared the outcomes of various GDP model forecasting exercises in pseudo real-time<sup>12</sup> of the revised version of the Spain-STING (described in detail in the second section), with the GDP forecast obtained as a weighted average of the forecasts for each component.

We observe that the GDP forecast according to the revised version of the model (the yellow line in Chart 1) was closer to the actual GDP figure (the blue line) than the GDP forecast obtained as a weighted average of the forecasts for each component (the red line). In consequence, the GDP forecast obtained from the revised model was taken as given and the forecasts for each component were adjusted to that GDP figure.

GDP FORECASTS. RESULTS IN PSEUDO REAL TIME (2005 Q1 - 2016 Q3)

CHART 1



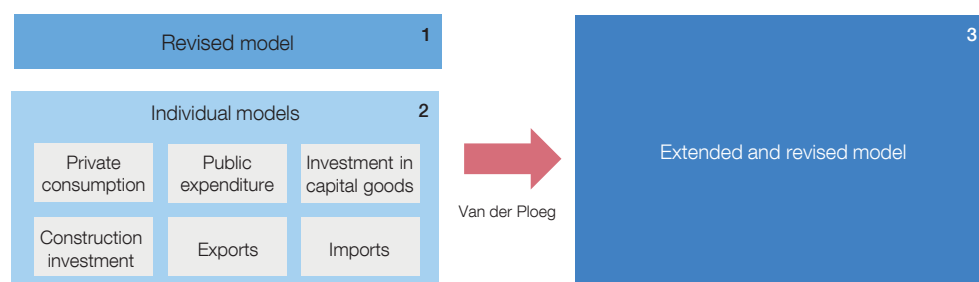
SOURCE: Banco de España.

<sup>12</sup> In this exercise the forecasts are compared out-of-sample. Specifically, the sample of the analysis runs from 2005 Q1 to 2016 Q3. In this exercise, the GDP that would have been obtained on a specific date in each quarter of the period (21 March, June, September and December) is forecast. For example, for 2005 Q1, all the indicators included are updated as at 21 March 2005. By contrast, in a real-time exercise the revisions of the different indicators are not included, but instead the figures published at the end of the sample period are used.

Scheme 1 depicts the new features of this version of the forecasting system in graphic form. In order to obtain a fully consistent forecasting framework, a balancing procedure is necessary, combining both the forecast GDP according to the revised model and the forecasts of each GDP component through the separate models. To that end, we have relied on the van der Ploeg (1982 and 1985) method, which allows consistent forecasting of macroeconomic aggregates through an equilibrium model.

#### SHORT-TERM FORECASTING MODEL FOR GDP AND ITS DEMAND COMPONENTS (SPAIN-STING) (a)

SCHEME 1



SOURCE: Banco de España.

**a** The revised dynamic factor model includes a technical improvement compared with the previous model. Drawing on this new model, individual models are estimated for each demand component. In this way a GDP forecast is obtained based on the revised model [1], and a weighted GDP forecast based on the individual models [2]. Owing to the enhanced predictive power of the revised model, a reconciliation method is used to ensure that the weighted sum of the forecasts of each component of GDP is equal to the revised model forecast. Thus, an extended and revised model [3] is obtained for forecasting GDP and its components.

The technique proposed by van der Ploeg explicitly recognizes the uncertainty surrounding the preliminary estimates and uses them as an essential element of the balancing process. Also, it is statistically robust and, at the same time, generates globally consistent estimates.

Following the method proposed by Abad et al. (2006), we minimise an objective function that penalises the level of breach of certain constraints, weighted according to the level of confidence attached by the forecaster to the initial estimates (revised according to the degree of accuracy). This method explicitly incorporates the uncertainty surrounding the flash estimates and uses it as an essential element in the balancing procedure, such that the final estimates satisfy the constraints of the system and, at the same time, include a specific measure of their accuracy.

Let  $Y_t$  be a vector representing the estimates of  $k$  variables, in our case, the growth contribution of every demand component, final consumption expenditure of households and NPISHs; final consumption expenditure of general government; gross fixed capital formation in capital goods; gross fixed capital formation in construction; and exports and imports of goods and services.

The final (balanced) forecast ( $Z_t$ ) must satisfy  $h$  linear constraints of the form:

$$AZ_t = a_t$$

where  $A_{n \times M}$  and  $A_{n \times 1}$  represent, respectively, the general structure and the final numeric values of such restrictions written in matrix form. In our case,  $a_{1 \times k} = (1, 1, 1, 1, 1, -1)$  and  $a_{1 \times 1} = \text{GDP}_t$  where  $\text{GDP}_t$  is the forecast estimated with the aggregate model.

$$\min_Z \phi = (Z_t - Y_t)' \Sigma^{-1} (Z_t - Y_t) \quad \text{s.t.} \quad AZ_t = a_t$$

In other words, the initial estimates are modified taking into account their discrepancies, weighted according to their reliability.  $\Sigma$  represents the variance covariance matrix of the forecasting errors of the individual disaggregated models and the actual releases. The objective function weights the squared deviations of each unbalanced estimate from the balanced version; weights are inversely related to the quality of the estimate, i.e. the higher the precision, the higher the weight.

## 4 Predictive power assessment

To assess the performance of the extended and revised version of the Spain-STING model compared with its predecessor, several forecasting exercises were conducted in pseudo real-time, i.e. out-of-sample.<sup>13</sup> First, we test the accuracy of the proposed model of Spanish GDP with respect to the previous version by computing mean squared errors and some econometric regressions to assess its possible bias. Second, we focus on the demand-side components and compute the mean squared errors with respect to other time series models.

### 4.1 GDP model

In this exercise, we compare the 2013 version of Camacho and Pérez-Quirós (2011),<sup>14</sup> which is named “previous model”, with the model that we propose in this paper, we refer to it as “revised and extended model”. We use a sample that covers from 2005 Q1 to 2016 Q3; the forecast is that which each model would produce on a specific date in each quarter of the selected period.<sup>15</sup> The exercise was conducted with a data sample running from January 1990 to September 2016 and the findings obtained for each of the two models were compared.

Table 8 and Chart 2 present the mean square errors vis-à-vis GDP and the GDP flash estimate. The technical improvement included in the specification of the new extended Spain-STING model marginally improves the accuracy of the forecasts of the previous model. Also, interestingly, a bias is observed between the GDP and the flash estimate series, which, a posteriori, causes the prediction errors of models such as that proposed in this article to increase considerably once revisions of the data series are incorporated. It is essential to stress that both the previous Spain-STING model and the extended Spain-STING model predict the GDP flash estimate better and more accurately than they do GDP; accordingly, the forecasting errors of models of this kind must be interpreted with caution once the final GDP figure is published and revised.

COMPARISON OF SUM OF MEAN SQUARE ERRORS (2005 Q1 - 2016 Q3)

TABLE 8

MSE compared with	Real GDP figure	GDP flash estimate
Previous model	5.3	1.9
Revised and extended model	4.4	1.7

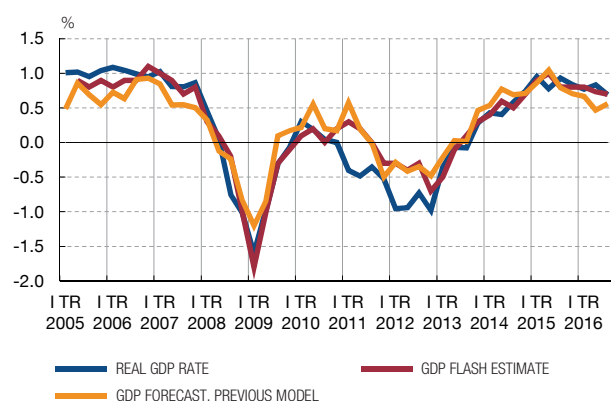
SOURCE: Banco de España.

<sup>13</sup> Owing to data availability problems, the exercise was conducted without taking into account the revision of the explanatory variables.

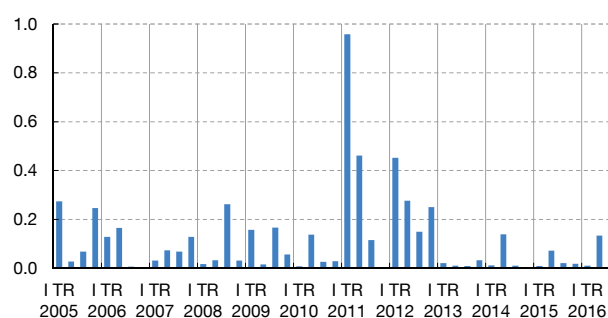
<sup>14</sup> This specification includes the first two changes described in subsection 2.2 of this paper.

<sup>15</sup> Specifically, we run the model on the 21<sup>st</sup> of the months of March, June, September and December.

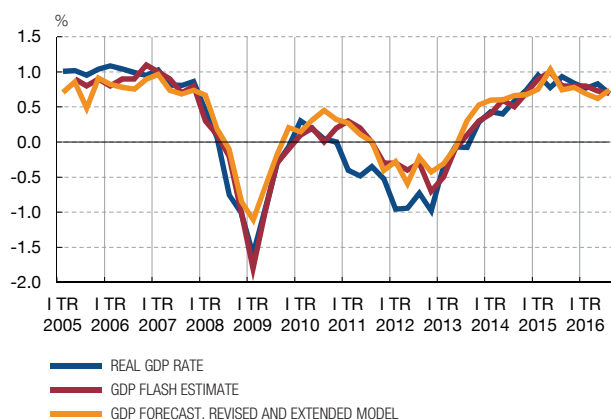
1 REAL RATE, GDP FLASH ESTIMATE AND GDP FORECAST. PREVIOUS MODEL (PSEUDO REAL TIME EXERCISE)



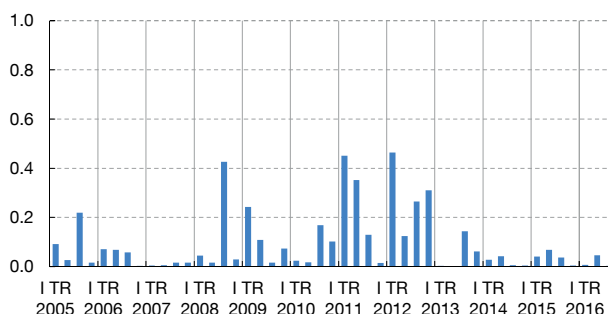
2 MEAN SQUARE ERRORS. PREVIOUS MODEL (PSEUDO REAL TIME EXERCISE)



3 REAL RATE, GDP FLASH ESTIMATE AND GDP FORECAST. REVISED AND EXTENDED MODEL



4 MEAN SQUARE ERRORS. REVISED AND EXTENDED MODEL



SOURCE: Banco de España.

Although the Mean Squared Error is the most commonly used measure of accuracy, it is useful to complement this measure with some additional regression that could illustrate potential biases on the forecasts. In particular, we have run a set of regressions of the GDP flash estimates on the forecasts obtained with the previous and the revised version of the model. As can be seen in the upper panel of Table 9, in both cases, we cannot reject the null hypothesis that the constant of the regression is 0 neither at 1% nor at 5% significance level, that is, there is no systematic bias. Furthermore, in our proposed model there is no systematic error related to the conditions of the economy. The estimated slope in the revised model is equal to one, i.e., the forecast is quite accurate, it is not the case that the model systematically overpredicts in some cases and underpredicts in others and so, both errors offset each other. These features are more clearly appreciated in the revised version of the model where additionally, the R-squared in the regression that uses the forecasts of the revised version is higher (0.91, and 0.88 for the previous version).

Then, we repeat the same analysis being the real GDP our dependent variable instead of the flash estimates (lower panel of Table 9). In this case, we find a systematic bias in both

the previous and the revised version of the model. As can be seen in the table, the constant is different from 0 and the slope is systematically higher than one.

We delve deeper on this issue and we run an additional regression of the real GDP on its flash estimates (displayed in Table 10). We find that the GDP flash, when used as a regressor is also affected by this bias, which could be associated to the revisions of the data used to calculate the final version of the GDP. Nevertheless, analyzing the source of this bias in the production of the Spanish GDP data exceeds the purpose of this paper.

REGRESSION OUTCOMES. LEAST SQUARES ESTIMATES. 2005 Q2 - 2016 Q3 (a)

TABLE 9

# 1 REGRESSION FOR GDP FLASH ESTIMATE

Dependent variable: GDP Flash estimate	(1)	(2)
	Previous model	Revised model
Constant	-0.05 * [0.03] (-1.7)	-0.07 * [0.04] (-1.85)
Forecast	1.14 *** [0.05] (21.30)	1.01 *** [0.05] (18.34)
R-squared	0.88	0.91
Adjusted R-squared	0.88	0.91
Included observations	46	46

# 2 REGRESSION FOR REAL GDP

Dependent variable: Real GDP	(1)	(2)
	Previous model	Revised model
Constant	-0.16 *** [0.05] (-3.2)	-0.19 *** [0.04] (-4.64)
Forecast	1.27 *** [0.08] (15.36)	1.17 *** [0.06] (19.24)
R-squared	0.84	0.89
Adjusted R-squared	0.84	0.89
Included observations	46	46

SOURCE: Banco de España.

a Standard errors in brackets. t-statistic in parentheses. \* indicates p-value less than 0.10, \*\* indicates a p-value less than 0.05, and \*\*\* indicates a p-value less than 0.01.

Dependent variable: Real GDP

	-0.09 **
Constant	[0.04]
	(-2.36)
	1.09 ***
GDP Flash estimate	[0.06]
	(19.07)
R-squared	0.89
Adjusted R-squared	0.89
Included observations	46

SOURCE: Banco de España.

a Standard errors in brackets. t-statistic in parentheses. \* indicates p-value less than 0.10, \*\* indicates a p-value less than 0.05, and \*\*\* indicates a p-value less than 0.01.

#### 4.2. Demand components models

In the previous subsection, we have seen that the best GDP forecast is obtained with the revised model. In this section, we compare the performance of dynamic factor models and the balancing procedure in forecasting each of the demand components of the GDP with respect to alternative time series models.

Specifically, we have computed an autoregressive model (AR) for each demand component and a vector-autoregressive model (VAR) that specifies a group of economic series, i.e. the six demand components of GDP, as a function of each series' past values to obtain a predictive reference of alternative models. In both of these specifications, we use four lags since the frequency of the data is quarterly. The forecasts of the univariate and multivariate models has been carried out using Tramo-Seats [see Gómez and Maravall (1996) and Caporello and Maravall (2004)]. The weighted results of these models are used to estimate a GDP forecast.

Therefore, in this subsection, we compare (i) the forecasts of the dynamic factor models of each demand component (free-forecast model); (ii) the forecasts obtained with the revised and extended model that uses the balancing procedure; (iii) the forecasts get using AR models and; (iv) the forecast obtained through a VAR specification. All these forecasting exercises are conducted in pseudo real-time.

The pseudo real-time exercises are run for the period covering from 2005 Q1 to 2017 Q2. We obtain a forecast within each quarter. This forecast is that which each model would return on a specific date in each quarter of the selected period.<sup>16</sup> These exercises were conducted with a data sample running from January 1990 to June 2017.

Table 11 and Chart 3 present the average of mean square errors of the models of each demand component vis-à-vis the figures of these macroeconomic aggregates published in the

<sup>16</sup> Specifically, 21 March, June, September and December of each quarter.



Quarterly National Accounts (Spanish Statistical Office). The forecasts obtained with the AR and the VAR models have the largest deviations from the real value, as expected. In general, the best approach to predict each component is using a balancing procedure, i.e. van der Ploeg.

**COMPARISON OF THE AVERAGE OF MEAN SQUARE ERRORS (2005 Q1 - 2017 Q2)** **TABLE 11**

	Model-free forecast	Van der Ploeg	AR	VAR
MSE compared with				
Private consumption	0.5	0.3	0.7	1.5
Investment in capital goods	4.9	5.2	14.0	17.1
Construction investment	3.7	2.6	2.7	3.7
Public expenditure	0.3	0.3	0.3	0.7
Exports	3.0	2.9	6.2	13.2
Imports	2.9	3.2	17.5	28.7
Real GDP	0.2	0.1	0.4	0.2

SOURCE: Banco de España.

For instance, for private consumption, the forecast obtained with van der Ploeg procedure is the best in terms of average of mean square errors. If we observe the free-forecast, the average of the errors is somewhat higher than with the balancing procedure, but it is still low. Finally, we see that the least desirable methods are the AR and the VAR models.

Although not all of the forecasts errors of the demand components behave the same, the GDP forecast using van der Ploeg is the optimum. On this basis, it may be inferred that the revised and extended Spain-STING model is the best procedure to forecast GDP and its demand components due to its technical improvement in the specification.

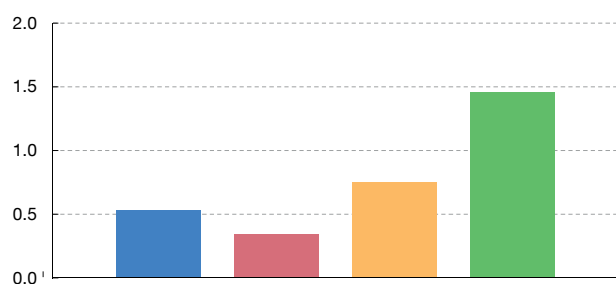
Furthermore, a real time analysis with the same techniques aforementioned (free-forecast, van der Ploeg balancing procedure, AR and VAR specifications) have been conducted for 2017 Q1, 2017 Q2 and 2017 Q3. The mean squares errors show us that, in general, the forecast made with the balancing procedure for each demand component and for the GDP is the best strategy.<sup>17</sup> However, it should be noticed that this analysis was run for very few quarters and it is necessary to take into consideration the possible future revisions of the data.

<sup>17</sup> Concretely, the average for the three quarters of the mean square errors of all demand components is 1.8 for the free-forecast, 1 for the van der Ploeg procedure, 1.8 for the AR and 2.3 for the VAR.

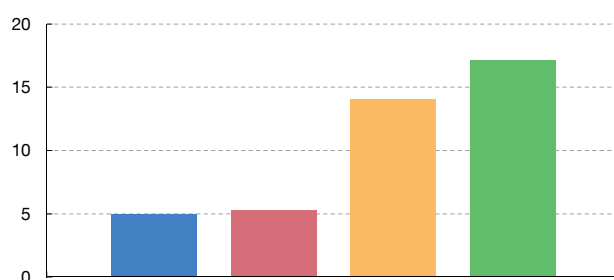
COMPARISON OF THE AVERAGE OF MEAN SQUARE ERRORS (2005 Q1 - 2017 Q2)

CHART 3

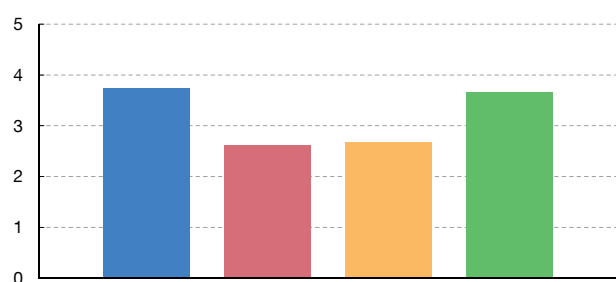
1 PRIVATE CONSUMPTION MODEL (PSEUDO REAL TIME EXERCISE)



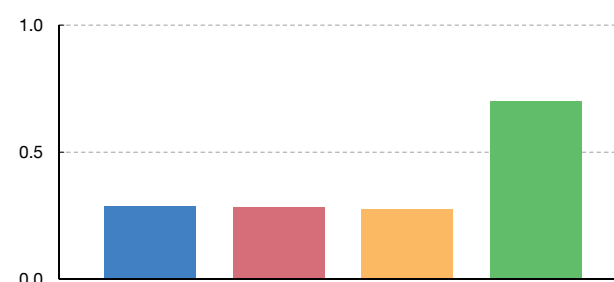
2 INVESTMENT IN CAPITAL GOODS MODEL (PSEUDO REAL TIME EXERCISE)



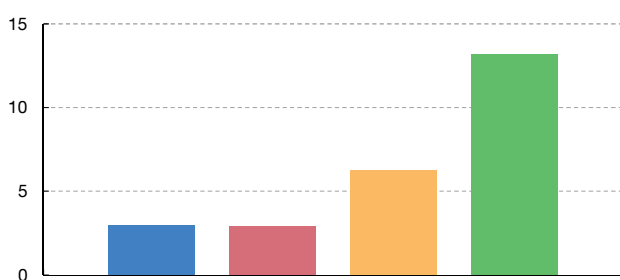
3 CONSTRUCTION INVESTMENT MODEL (PSEUDO REAL TIME EXERCISE)



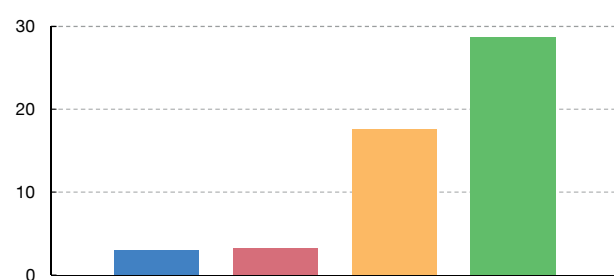
4 PUBLIC EXPENDITURE MODEL (PSEUDO REAL TIME EXERCISE)



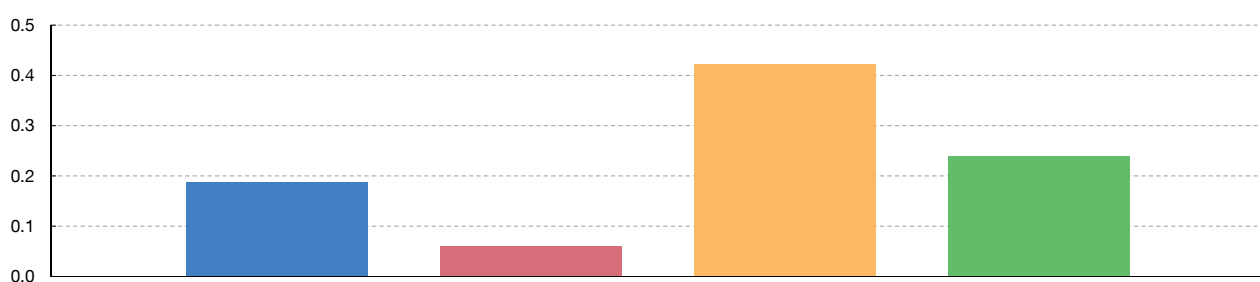
5 EXPORTS MODEL (PSEUDO REAL TIME EXERCISE)



6 IMPORTS MODEL (PSEUDO REAL TIME EXERCISE)



7 REVISED GDP MODEL (PSEUDO REAL TIME EXERCISE)



FREE-FORECAST    VAN DER PLOEG    AR    VAR

SOURCE: Banco de España.

## 5 Final remarks

Making forecasts on the future course of the economy is a fundamental task of Central Banks and national and international institutions. For instance, forecasts are considered in order to design appropriate economic policies, such as monetary and fiscal ones.

To this end, this paper proposes a short-term forecasting model for the Spanish economy (GDP and its demand components). In particular, we estimate an extended and revised version of Spain-STING (Spain, Short-Term INDicator of Growth). On the one hand, it entails a technical improvement in the econometric specification. On the other hand, not only GDP is forecast but also its demand components. In order to do that, drawing on a broad set of indicators, several dynamic factors models have been estimated.

The assessment of the predictive power of the GDP and its demand components shows that for the former, we find some improvement on the previous version of the model, while for the later, we find the accuracy of our proposal is better than other alternative time series models.

## REFERENCES

- ABAD, A., M., A. CUEVAS and E. M. QUILIS (2006). "Proyección del cuadro macroeconómico y de las cuentas de los sectores institucionales mediante un modelo de equilibrio", Papeles de Trabajo, num. 27/06, Instituto de Estudios Fiscales.
- ÁLVAREZ, F. (1989). "Base estadística en España de la Contabilidad Nacional Trimestral", Revista Española de Economía, 6 (1-2), pp. 59-84.
- ÁLVAREZ, R. (2005). "Notas sobre fuentes estadísticas", in Servicio de Estudios del Banco de España, *El análisis de la economía española*, Alianza Editorial.
- ÁLVAREZ, L.J., CABRERO, A. and A. URTASUN (2014). "Un procedimiento para la predicción a corto plazo del PIB". Artículo Analítico, Boletín Económico octubre, 2014, Banco de España.
- ARENCIBIA, A., GÓMEZ LOSCOS, A., DE LUIS LÓPEZ, M. and G. PÉREZ-QUIROS (2017). "A short-term forecasting model for GDP and its demand components". Analytical Article, Economic Bulletin 4/2017, Banco de España.
- BURRIEL, P. and M. I. GARCIA BELMOTE (2013). "Meeting our Dēstiny: A disaggregated Euro area short term indicator model to forecast GDP (Y) growth", Working Paper 1323, Banco de España.
- CAMACHO, M. and G. PEREZ-QUIROS (2009). "Ñ-STING: España Short Term Indicator of Growth", Working Paper 0912, Banco de España.
- (2010). "Introducing the euro-sting: Short-term indicator of euro area growth", Journal of Applied Econometrics, 25(4), pp. 663-694.
- (2011). "Spain-Sting: Spain Short-Term Indicator of Growth", Manchester School, 79(1), pp. 594-616.
- CAPORELLO, G. and A. MARAVALL (2004). "Program TSW. Revised manual", Bank of Spain, Occasional Paper n. 0408.
- CUEVAS, A., PEREZ QUIROS, G. and E. M. QUILIS (2017). "Integrated model of short-term forecasting of the Spanish economy (MIPred model)". Revista de Economía Aplicada, 74 (XXV), pp. 5-25.
- EUROPEAN COMMISSION (2006). "The joint harmonized EU programme of business and consumer surveys", Special Report, n. 5/2006.
- GÓMEZ, V. and A. MARAVALL (1996). "Programs TRAMO and SEATS", Bank of Spain, Working Paper n. 9628.
- HAMILTON, J. (1994). "State-space models", Handbook of Econometrics, Vol. 4, edited by R. Engle and D. McFadden, North-Holland.
- MARIANO, R., and Y. MURASAWA (2003). "A new coincident index of business cycles based on monthly and quarterly series", Journal of Applied Econometrics, 18, pp. 427-443.
- STOCK, J. and M. WATSON (1991). "A probability model of the Coincident Economic Indicators", Leading Economic Indicators: New Approaches and Forecasting Records, ed. K. Lahiri and G.H. Moore. Cambridge. Cambridge University Press, 63-89(3).
- VAN DER PLOEG, F. (1982). "Reliability and the Adjustment of Large Economic Accounting Matrices", Journal of the Royal Statistical Society, series A, 145(2), pp. 169-194.
- (1985). "Econometrics and Inconsistencies in the National Accounts", Economic Modelling, January, pp. 8-16.

## Appendix 1. Matrix. GDP Model

### Acronyms

GDP: Gross Domestic Product

ESI: Economic Sentiment Indicator

PMI: Purchasing Managers Index

IPI: Industrial Production Index

SLF: Sales of large firms

CEM: Apparent consumption of cement

SSR: Social Security registrations

ELE: Electricity consumption in industry

CRE: Credit to non-financial corporations

EXP: Goods exports

IMP: Goods imports

## GPD MODEL

$$Y_t = \begin{bmatrix} \Delta y_{GDPt} \\ \Delta y_{ESIt} \\ \Delta y_{PMIt} \\ \Delta y_{IPIt} \\ \Delta y_{SLFt} \\ \Delta y_{CEMt} \\ \Delta y_{SSRt} \\ \Delta y_{ELEt} \\ \Delta y_{CREt} \\ \Delta y_{EXPt} \\ \Delta y_{IMPt} \end{bmatrix}$$

[illegible]

$$S_t = \begin{bmatrix} f_{t-3} \\ f_{t-2} \\ f_{t-1} \\ f_t \\ f_{t-1} \\ f_{t-2} \\ f_{t-3} \\ f_{t-4} \\ f_{t-5} \\ f_{t-6} \\ f_{t-7} \\ f_{t-8} \\ GDP_t \\ GDP_{t-1} \\ GDP_{t-2} \\ GDP_{t-3} \\ GDP_{t-4} \\ ESI_t \\ ESI_{t-1} \\ PMI_t \\ PMI_{t-1} \\ IPI_t \\ IPI_{t-1} \\ SLF_t \\ SLF_{t-1} \\ CEM_t \\ CEM_{t-1} \\ CEM_t \\ SSR_t \\ SSR_{t-1} \\ ELE_t \\ ELE_{t-1} \\ CRE_t \\ CRE_{t-1} \\ EXP_t \\ EXP_{t-1} \\ IMP_t \\ IMP_{t-1} \end{bmatrix}$$

$$F = \begin{bmatrix} F_1 & 0_{12,5} & 0_{12,20} \\ 0_{5,12} & F_2 & 0_{5,20} \\ 0_{20,12} & 0_{20,5} & F_3 \end{bmatrix}_{37 \times 37}$$

Where

$$F_1 = \begin{bmatrix} \phi_1 & \phi_2 & . & . & . & 0 & 0 \\ 1 & 0 & . & . & . & 0 & 0 \\ 0 & 1 & 0 & . & . & . & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & 0 & . & . & . & 1 & 0 \end{bmatrix}_{12 \times 12}$$

$$F_2 = \begin{bmatrix} \phi_3 & \phi_4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}_{5 \times 5}$$

$$F_3 = \begin{bmatrix} \varphi_{11} & \varphi_{12} & 0 & 0 & 0 & . & . & . & 0 \\ 1 & 0 & 0 & 0 & 0 & . & . & . & 0 \\ 0 & 0 & \varphi_{21} & \varphi_{22} & 0 & . & . & . & 0 \\ 0 & 0 & 1 & 0 & 0 & . & . & . & 0 \\ . & . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . & 0 \\ . & . & . & . & . & . & . & . & 0 \\ 0 & 0 & 0 & . & . & . & 1 & 0 & 0 \end{bmatrix}_{20 \times 20}$$

## Appendix 2. Matrices. Demand Components Models

### Acronyms

CON: Private consumption  
PBE: Public expenditure  
ICG: Investment in capital goods  
CTR: Construction investment  
EXP: Exports of goods and services  
IMP: Imports of goods and services  
ESI: Economic Sentiment Indicator  
PMI: Purchasing Managers Index  
IPI: Industrial Production Index  
SLF: Sales of large firms  
CEM: Apparent consumption of cement  
SSR: Social Security registrations  
SSA: Service Sector Activity Indicator  
CNF: Confidence Indicator  
RTI: Retail trade index  
UNP: Unemployment rate  
POP: Point of purchase (number of card transactions)  
EIG: Employment income – general government  
STE: State expenditure  
VEH: New commercial vehicle registrations  
FIN: Financing to households and NPISHs  
BUI: Building permits  
WGT: World goods trade  
GEX: Total goods exports  
TOU: Total tourist inflows  
CPI: Consumer Price Index

## PRIVATE CONSUMPTION MODEL

$$Y_t =$$

$$H = 9 \times 33$$

$$S_t =$$

$$33 \times 1$$



## PUBLIC EXPENDITURE MODEL

$$Y_t = \begin{bmatrix} \Delta y_{PBE_t} \\ \Delta y_{SSR_t} \\ \Delta y_{EIG_t} \\ \Delta y_{STE_t} \end{bmatrix}$$

$$H = \begin{bmatrix} \frac{1}{3} Y_{PBE} & \frac{2}{3} Y_{PBE} & Y_{PBE} & \frac{2}{3} Y_{PBE} & \frac{1}{3} Y_{PBE} & \frac{1}{3} & \frac{2}{3} & 1 & \frac{2}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 \\ Y_{SSR} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ Y_{EIG} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ Y_{STE} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F = \begin{bmatrix} F_1 & 0_{5,5} & 0_{5,6} \\ 0_{5,5} & F_2 & 0_{5,6} \\ 0_{6,5} & 0_{6,5} & F_3 \end{bmatrix}$$

Where

$$S_t = \begin{bmatrix} f_t \\ f_{t-1} \\ f_{t-2} \\ f_{t-3} \\ f_{t-4} \\ e_{PBE_t} \\ e_{PBE_{t-1}} \\ e_{PBE_{t-2}} \\ e_{PBE_{t-3}} \\ e_{PBE_{t-4}} \\ e_{SSR_t} \\ e_{SSR_{t-1}} \\ e_{EIG_t} \\ e_{EIG_{t-1}} \\ e_{STE_t} \\ e_{STE_{t-1}} \end{bmatrix}$$

$$F_1 = \begin{bmatrix} \phi_1 & \phi_2 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F_2 = \begin{bmatrix} \phi_3 & \phi_4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F_3 = \begin{bmatrix} \varphi_{11} & \varphi_{12} & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \varphi_{21} & \varphi_{22} & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \varphi_{31} & \varphi_{32} \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

## INVESTMENT IN CAPITAL GOODS MODEL

$$Y_t = \begin{bmatrix} \Delta y_{ICG_t} \\ \Delta y_{IPI_t} \\ \Delta y_{VEH_t} \\ \Delta y_{SLF_t} \\ \Delta y_{ESI_t} \end{bmatrix}$$

$$H = \begin{bmatrix} 0 & 0 & 0 & \frac{1}{3}Y_{ICG} & \frac{2}{3}Y_{ICG} & Y_{ICG} & \frac{2}{3}Y_{ICG} & \frac{1}{3}Y_{ICG} & 0 & 0 & 0 & 0 & \frac{1}{3} & \frac{2}{3} & 1 & \frac{2}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{IPI} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{VEH} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{SLF} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & Y_{ESI} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F = \begin{bmatrix} F_1 & 0_{12,5} & 0_{12,8} \\ 0_{5,12} & F_2 & 0_{5,8} \\ 0_{8,12} & 0_{8,5} & F_3 \end{bmatrix}$$

Where

$$F_1 = \begin{bmatrix} \phi_1 & \phi_2 & . & . & 0 & 0 \\ 1 & 0 & . & . & 0 & 0 \\ 0 & 1 & 0 & . & . & 0 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & 0 & . & . & 1 & 0 \end{bmatrix}$$

$$F_2 = \begin{bmatrix} \phi_3 & \phi_4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F_3 = \begin{bmatrix} \phi_{11} & \phi_{12} & 0 & 0 & . & . & . & 0 \\ 1 & 0 & 0 & 0 & . & . & . & 0 \\ 0 & 0 & \phi_{21} & \phi_{22} & . & . & . & 0 \\ 0 & 0 & 1 & 0 & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & \phi_{41} & \phi_{42} & . & . \\ 0 & . & . & . & 1 & 0 & . & . \end{bmatrix}$$

$$S_t = \begin{bmatrix} f_{t-3} \\ f_{t-2} \\ f_{t-1} \\ f_t \\ f_{t-1} \\ f_{t-2} \\ f_{t-3} \\ f_{t-4} \\ f_{t-5} \\ f_{t-6} \\ f_{t-7} \\ f_{t-8} \\ e_{ICG_t} \\ e_{ICG_{t-1}} \\ e_{ICG_{t-2}} \\ e_{ICG_{t-3}} \\ e_{ICG_{t-4}} \\ e_{IPI_t} \\ e_{IPI_{t-1}} \\ e_{VEH_t} \\ e_{VEH_{t-1}} \\ e_{SLF_t} \\ e_{SLF_{t-1}} \\ e_{ESI_t} \\ e_{ESI_{t-1}} \end{bmatrix}$$

## CONSTRUCTION INVESTMENT MODEL

$$Y_t = \begin{bmatrix} \Delta y_{CTR_t} \\ \Delta y_{SSR_t} \\ \Delta y_{CNF_t} \\ \Delta y_{FDN_t} \\ \Delta y_{CEM_t} \\ \Delta y_{BUI_t} \\ \Delta y_{SLF_t} \end{bmatrix}$$

$$\mathbf{H}_{7 \times 29} = \begin{bmatrix} 0 & 0 & 0 & \frac{1}{3}Y_{CTR} & \frac{2}{3}Y_{CTR} & Y_{CTR} & \frac{2}{3}Y_{CTR} & \frac{1}{3}Y_{CTR} & 0 & 0 & 0 & 0 & \frac{1}{3} & \frac{2}{3} & 1 & \frac{2}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{SSR} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & Y_{CNF} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{FEN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ Y_{CEM} & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{BUI} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{SLF} & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

$$F = \begin{bmatrix} F_1 & 0_{12,5} & 0_{12,12} \\ 0_{5,12} & F_2 & 0_{5,12} \\ 0_{12,12} & 0_{12,5} & F_3 \end{bmatrix}$$

Where

$$S_t = \begin{bmatrix} f_{t-4} \\ f_{t-5} \\ f_{t-6} \\ f_{t-7} \\ f_{t-8} \\ @CTR_t \\ @CTR_{t-1} \\ @CTR_{t-2} \\ @CTR_{t-3} \\ @CTR_{t-4} \\ @SSR_t \\ @SSR_{t-1} \\ @CNF_t \\ @CNF_{t-1} \\ @FDN_t \\ @FDN_{t-1} \\ @CEM_t \\ @CEM_{t-1} \\ @BUI_t \\ @BUI_{t-1} \\ @SLF_t \\ @SLF_{t-1} \end{bmatrix} \quad F_1 = \begin{bmatrix} \phi_1 & \phi_2 & . & . & 0 & 0 \\ 1 & 0 & . & . & 0 & 0 \\ 0 & 1 & 0 & . & . & 0 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & 0 & . & . & 1 & 0 \end{bmatrix} \quad F_2 = \begin{bmatrix} \phi_3 & \phi_4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \quad F_3 = \begin{bmatrix} \phi_{11} & \phi_{12} & 0 & 0 & . & . & 0 \\ 1 & 0 & 0 & 0 & . & . & 0 \\ 0 & 0 & \phi_{21} & \phi_{22} & . & . & 0 \\ 0 & 0 & 1 & 0 & . & . & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & . & . & . & . & . & . \end{bmatrix} \quad \begin{matrix} \phi_{s1} & \phi_{s2} \\ 1 & 0 \end{matrix}$$

[illegible]

# IMPORTS OF GOODS AND SERVICES MODEL

$$Y_t = \begin{bmatrix} \Delta Y_{IMP,t} \\ \Delta Y_{IPI,t} \\ \Delta Y_{WGT,t} \\ \Delta Y_{SLF,t} \\ \Delta Y_{PMI,t} \end{bmatrix}$$

$$H = \begin{bmatrix} 0 & 0 & 0 & \frac{1}{3}Y_{IMP} & \frac{2}{3}Y_{IMP} & Y_{IMP} & \frac{2}{3}Y_{IMP} & \frac{1}{3}Y_{IMP} & 0 & 0 & 0 & 0 & \frac{1}{3} & \frac{2}{3} & 1 & \frac{2}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{IPI} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{WGT} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Y_{SLF} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & Y_{PMI} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$S_t = \begin{bmatrix} f_{t+3} \\ f_{t+2} \\ f_{t+1} \\ f_t \\ f_{t-1} \\ f_{t-2} \\ f_{t-3} \\ f_{t-4} \\ f_{t-5} \\ f_{t-6} \\ f_{t-7} \\ f_{t-8} \\ e_{IMP,t} \\ e_{IMP,t-1} \\ e_{IMP,t-2} \\ e_{IMP,t-3} \\ e_{IMP,t-4} \\ e_{IPI,t} \\ e_{IPI,t-1} \\ e_{WGT,t} \\ e_{WGT,t-1} \\ e_{SLF,t} \\ e_{SLF,t-1} \\ e_{PMI,t} \\ e_{PMI,t-1} \end{bmatrix}$$

$$F = \begin{bmatrix} F_1 & 0_{12,5} & 0_{12,8} \\ 0_{5,12} & F_2 & 0_{5,8} \\ 0_{8,12} & 0_{8,5} & F_3 \end{bmatrix}$$

Where

$$F_1 = \begin{bmatrix} \phi_1 & \phi_2 & . & . & . & 0 & 0 \\ 1 & 0 & . & . & . & 0 & 0 \\ 0 & 1 & 0 & . & . & . & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & 0 & . & . & . & 1 & 0 \end{bmatrix}$$

$$F_2 = \begin{bmatrix} \phi_3 & \phi_4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$F_3 = \begin{bmatrix} \varphi_{1,1} & \varphi_{1,2} & 0 & 0 & . & . & . & 0 \\ 1 & 0 & 0 & 0 & . & . & . & 0 \\ 0 & 0 & \varphi_{2,1} & \varphi_{2,2} & . & . & . & 0 \\ 0 & 0 & 1 & 0 & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 0 & . & . & . & . & 1 & 0 & 0 \end{bmatrix}$$

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